

54. Cirripedes from the Cenomanian Chalk Marl of Cambridge. By THOMAS H. WITHERS, F.G.S.*

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(Plates XCIV. & XCV.†)

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Through the industry of the late Mr. F. Mockler, I have been enabled to examine a large series of Cirripede remains which he obtained from the Cenomanian Chalk Marl in the neighbourhood of Cambridge. By far the greater number can be referred to two species, which add materially to our knowledge of the phylogeny of the pedunculate Cirripedes.

One, *Zeugmatolepas mockleri*, gen. et sp. n., is represented by two nearly complete capitula and portions of nine others, as well as a large number of isolated valves. It is interesting from the fact that, while it agrees with the species of *Pollicipes* in the number of valves of the capitulum, it differs not only in the more specialized form of scutum, but also in the size and position of the upper latera, which are nearly as large as the scuta, and have become elevated to occupy the whole of the space between the scuta and terga. This form certainly serves more than any other to connect the genus *Pollicipes* to *Scalpellum*, and, together with *S. (?) cretæ* Steenstrup sp., from the Upper Senonian of Denmark, is now included in the new genus *Zeugmatolepas*.

The second species, *Scalpellum tuberculatum* Darwin, is represented by a large number of separated valves, including several not previously known. These enable us not only to reconstruct the capitulum, but also to show that the species must be referred to the genus *Calantica* Gray. Representatives of that genus are now found living, and the geologically oldest species of its subgenus *Scillelepas*, to which *Scalpellum tuberculatum* comes nearest, occurs in the Miocene of Italy. The recent and Tertiary species have the umbones of all the valves apical, so that it is surprising to find in the Cretaceous representative,

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† For explanation of the Plates see p. 948.

S. tuberculatum, a more specialized form of scutum, the umbo being subcentral. On account of its higher evolutionary development, *S. tuberculatum* is placed in a new subgenus of *Calantica*, namely *Titanolepas*, and it is here suggested that this form may represent an offshoot from the ancestral *Scillalepas* line, and may eventually have given rise to the genus *Oxyaspis*.

Both species are remarkable in having an advanced form of scutum in which the umbo is subcentral, and, together with a small undescribed species of which only the carina is known, constitute the oldest known examples of this specialized type of valve. It is quite evident that *Zeugmatolepas mockleri* and *Titanolepas tuberculata* are derived from either the genus *Pollicipes* or from a *Pollicipes*-like ancestor, and both have evolved the same type of scutum. These forms seem to show that the transition of the umbo in the scutum from an apical to a subcentral position, has occurred independently in unrelated forms belonging to distinct lines of development, and recent work leads me to believe that this is equally true also of the carina in the more advanced forms of *Scalpellum* (*sensu lato*). In *T. tuberculata* the position of the umbo in the scutum is constant; but in *Z. mockleri* it changes apparently according to age, although some individuals seem to be more advanced in this respect. It may be, therefore, that in the scutum of *Z. mockleri* the subcentral umbo was quite a recent development.

The two species must have been comparatively common in the Chalk sea, for of *Zeugmatolepas mockleri* we have remains of at least 100 capitula, and of *Titanolepas tuberculata* more than 30.

FAMILY POLLICIPEDIDÆ.

ZEUGMATOLEPAS*, gen. nov.

Capitulum longer than broad, comprising at least 34 valves, composed of scuta, terga, upper latera, and carina, and three or more whorls of subtriangular lower latera, with a rostrum, subrostrum, and subcarina; upper latera almost as large as the scuta, occupying the whole of the space between the scuta and terga, the apices of the upper latera contiguous with those of the scuta; umbo of scuta subcentral, and of the remaining valves apical.

Genotype.—*Zeugmatolepas mockleri*.

ZEUGMATOLEPAS MOCKLERI, sp. n. (Plate XCIV. figs. 1–14.)

Diagnosis.—Valves thin and generally smooth. Carina narrow, usually with a strong, median, rounded keel, not divided off into parietes and intraparietes, basal margin acutely angular. Scutum subtriangular to trapezoidal in shape, with the umbo varying in position from just below the apex to about one-third the length of the valve from the apex; there is in most scuta a deep trough

* ζεύγμα = a connecting link.

above the umbo extending almost parallel to the upper occludent margin; apical portion usually constricted and acute; basilateral angle shortly and obliquely truncated. Tergum subrhomboidal, with its upper half curved towards the scuta; basal angle sometimes acute, but more often shortly and obliquely truncated.

Material.—Two almost complete capitula and nine portions of others. All of these appear to be immature, and there is also a large series of isolated valves.

Holotype.—The nearly complete capitulum, I. 15830 (Pl. XCIV. fig. 11).

Distribution.—Cambridge Greensand: Cambridge; Cenomanian, Chalk Marl: near Cambridge, and Burham, Kent; Cenomanian, *A. plena*-marls: Oxted, Surrey, and Wantage, Berkshire; [?Cenomanian], Chalk detritus: Charing, Kent.

Measurements.—The two nearly complete capitula (Pl. XCIV. figs. 11, 13) each measure 4 mm. from the apex of the scutum to the base of the lowest whorl of latera, and the uncrushed capitulum (Pl. XCIV. fig. 11) measures 4·2 mm. in breadth. Both are immature examples. Among the detached valves the largest examples of the upper series measure respectively:—

Carina, I. 15820. Length (valve slightly broken at apex) 5·9 mm.; breadth 1·7 mm.

Scutum, I. 15822. Length (from apex to lowest point of basal margin) 6·4 mm.: breadth 4·5 mm.

Tergum, I. 15833. Length 7·6 mm.; breadth 3·4 mm.

Upper latus, I. 15834. Length 4·5 mm.; breadth 3·2 mm.

There are, however, several fragments which show that these valves attained somewhat larger dimensions. A comparison of these with the proportions of the valves, as shown in the nearly complete capitulum, seems to show that the capitulum of the species reached a length of at least 15 mm.

Description of valves.—Valves thin, smooth, or ornamented with excessively fine ridges radiating from their umbones.

Carina (Pl. XCIV. figs. 1, 2) narrow, widening gradually downwards from the apex to the basal margin, either slightly bowed inwards, straight, or bowed outwards, not divided off into parietes and intraparietes; basal margin acutely angular; tectum slightly to moderately convex transversely; in some carinæ there is a strong, rounded, median, longitudinal keel, nearly as wide as the portion of the valve on either side, but in some specimens it is less strongly marked and in others barely perceptible. Inner surface somewhat thickened near the apex and marked with oblique growth-lines; the extent of the surface thus thickened varies, and at the most is one-third of the length of the valve; the valve therefore projected freely to a variable extent.

Scutum (Pl. XCIV. figs. 3-6) varying in shape from subtriangular to trapezoidal, moderately convex transversely, the surface of the valve sloping more steeply from the umbo to the lateral margin; umbo situated just below the apex in young specimens, and in mature examples usually occupying a position

about one-third the extent of the valve from the apex; above the umbo the valve is usually produced abruptly into an acute angle; lateral margin longer than the basal margin, almost straight in its lower part and usually sharply bent inwards and upwards above a line with the umbo; basal margin indistinctly marked off into three almost equal parts, the two outer parts being obliquely inclined towards the apex; lower occludent margin slightly convex, about the length of the basal margin; upper occludent margin about half the length of the lower occludent margin, sometimes nearly in line with it, but more often abruptly bent from the umbo towards the lateral margin, and in some cases almost in line with the umbo and nearly at right angles to the lower occludent margin. Almost all the specimens have a strong ridge extending from the umbo to a point just above it on the lateral margin, and above this ridge the narrow portion of the valve is sharply bent downwards and upwards, and forms a deep trough which is bounded by the raised upper occludent margin; three further ridges, not to be seen in some specimens, extend from the umbo to the basal margin, one to the basilateral angle, a second to one-third of the distance from the rostral angle, and a third to midway between the two. On the inner surface there is a deep pit for the adductor scutorum; the inner occludent margin is much thickened, and above the umbo a portion of the valve is bent downwards at right angles to the outer surface in some specimens, and in others it is sharply bent inwards; when the occludent margin is almost in line with the umbo, this downwardly and inwardly bent portion of the valve almost entirely overhangs the pit for the adductor scutorum, and forms a roof to the upper part of the inner surface.

Tergum (Pl. XCIV. fig. 7) subrhomboidal, slightly convex transversely, with a feebly marked curved ridge extending from the apex to the basal angle at about one-fifth the width of the valve from the carinal margin, and from this ridge the valve slopes steeply to the carinal margin; upper half of valve curved towards the scuta, and in most valves away from the opposing tergum; apex acute; basal angle sometimes acute, and sometimes slightly and obliquely truncated; carinal margin convex when continuous, but when formed of two almost equal portions, as is usually the case, the upper margin is convex and the lower margin almost straight; scutal or lateral margin straight, almost equal in length to the concave occludent margin, which has a slightly raised border; the shape of the upper carinal and occludent margins is influenced by the extent to which the upper half of the valve is curved towards the scuta, a character which is very variable. Along the occludent margin, especially in those examples conspicuously bowed away from the opposing tergum, a portion of the valve is bent downwards and sharply inwards to form an obtusely angular ledge on the inside of the valve; this ledge, as well as that formed on the inner occludent margin of the scutum, was no doubt for the protection of the animal's body,

for these ledges would serve to fill up the hiatus made through the upper portions of the scuta and terga being bowed away from each other. In some of the terga from the Chalk Marl of Cambridge and Burham, the adoccludent portion of the valve is not bent downwards and inwards to form a ledge on the inner surface, but extends outwards to form a second raised ridge almost parallel with the raised occludent margin. The terga from the *B. plena*-marls have this outer ridge finely denticulated on its margin.

Upper latus (Pl. XCIV. fig. 8) subtriangular, slightly curved towards the scuta, almost flat; umbo slightly projecting; at the scutal margin a narrow slip of the valve is bent downwards, and during the thickening and growth of the valve a slight ledge has been formed which has a tendency to project beyond the umbo; tergal margin slightly convex; scutal margin slightly concave, and about the same length as the tergal margin: basal margin marked off into three almost equal lines, and to the angles thus made two feebly marked ridges extend from the umbo.

Rostrum (Pl. XCIV. fig. 9) diamond-shape, bowed inwards; a strong rounded keel extends from the apex, widens gradually to the basal angle, and the portion of the valve on each side slopes steeply towards the lateral margins; apical portion acute; basal portion rather less acute than the apical portion, with the basal angle slightly rounded. The inside of the valve is deeply concave.

Structure and Affinities.—The capitulum of *Zeugmatolepas mockleri* (see restoration, Pl. XCIV. fig. 14) closely resembles that of *Pollicipes*, especially in the number of valves, but differs (1) in the more specialized form of scutum which has a subcentral umbo, (2) in the size and position of the upper latera, which are elevated to occupy the whole of the interval between the scuta and terga, and (3) in the capitulum being longer than broad, and therefore of a more erect and *Scalpellum*-like shape. In this form the umbo of the scutum appears generally to be almost apical in young valves, and to become further removed from the apex with age, until it reaches about one-third of the distance of the valve from the apex. Some individuals, however, have the umbo further removed from the apex than others of the same size. All the valves are exceedingly variable, much more so than in any fossil pedunculate Cirripede with which I am acquainted; these variations are noted under the descriptions of the several valves.

Zeugmatolepas mockleri agrees more closely with *S. (?) cretæ* Steenstrup* sp. from the Upper Senonian of Denmark than with any other species, and, indeed, *S. (?) cretæ* may quite well have been directly developed from *Z. mockleri*. Through the kindness of Dr. J. P. J. Ravn I have been able to examine examples of the known valves (scuta, terga, and carina) of *S. (?) cretæ* from

* Steenstrup, J., Krøyer's Naturhist. Tidsskrift, Bd. i. 1837, p. 359; Bd. ii. 1839, p. 399, pl. v. figs. 1-3; Darwin, C. R., Pal. Soc. Mon. Foss. Lepadidæ, 1851, p. 45, pl. i. figs. 11 a-c.

the collection of the Mineralogical Museum of the University of Copenhagen, and Dr. Ravn informs me that this species has been found only in the Upper Senonian (Zone of *Scaphites constrictus*). Darwin doubtfully referred *S. (?) cretæ* to the genus *Scalpellum*, and observed (1851, p. 45): "Professor Steenstrup was originally inclined to believe that the capitulum [of *S. (?) cretæ*] was formed of only five valves; could this be proved, the species would very naturally rank with a small recent one from the Island of Madeira, which, owing to the upward growth of the scuta, and to certain peculiarities in the animal's body, I have felt myself compelled to raise to the rank of a genus, under the name *Oxynaspis*." An examination of the valves from Copenhagen University, and of some valves obtained by myself from the matrix of a specimen presented to the Geological Department of the British Museum by Copenhagen University, shows, at any rate, that we can no longer hold Steenstrup's view that *S. (?) cretæ* had only five valves. Among the above valves are some small lower lateral plates, which, although not so well preserved as those from the English Cenomanian Chalk, obviously belong to the same general type as those of *Zeugmatolepas mockleri*. *S. (?) cretæ*, together with the species now described, is included, for the reasons previously given, in the new genus *Zeugmatolepas*.

The scutum of *Z. cretæ* differs from that of *Z. mockleri* in that the umbo is further removed from the apex, being situated almost midway on the occludent margin, and in a greater portion of the valve near the basi-lateral angle being sharply upturned almost at right angles to the middle part of the basal margin. The lateral (or tergal) portion of the valve is not steeply inclined from the umbo, and there is no deep trough, as in *Z. mockleri*, running parallel with the upper occludent margin. These and other differences result, no doubt, from the difference in position of the umbo, and the consequent greater development of the tergal or lateral portion of the valve. The carina in *Z. cretæ* is relatively wider than in *Z. mockleri*, the central ridge is much more obscure, and in the tergum there is a much wider groove near the occludent margin. The whole of the valves in *Z. cretæ* are appreciably thinner. These differences, however, while deserving of specific distinction, appear to result from the further development of valves like those of *Z. mockleri*, and consequently I consider these two species to be closely and probably directly related.

Genus CALANTICA.

1825. *Calantica* Gray, 'Annals of Philosophy' (n. s.), vol. x.
p. 101.
1907. *Calantica* Gray: Pilsbry, Bull. U.S. Nat. Mus. no. 60,
p. 8.
1908. *Calantica* Gray: Pilsbry, Proc. Acad. Nat. Sci. Philadelphia,
p. 166.

Capitulum with two whorls of valves, the upper comprising paired scuta, terga, and a carina, the terga occupying the whole

of the space between the scuta and carina; lower whorl comprising three pairs of latera, a rostrum, and a subcarina. Umbo of all valves apical.

The Oriental group, called by Pilsbry (1908) *Calantica* s. str., has the valves of the lower whorl low and wide, small, not concealing the bases of the valves of the upper whorl.

TITANOLEPAS *, subgen. nov.

Valves of lower whorl large, high, but not incurved, and overlapping the bases of the valves of the upper whorl. Umbo of scutum subcentral and of the remaining valves apical.

Genotype.—*Titanolepas tuberculata*.

CALANTICA (TITANOLEPAS) TUBERCULATA Darwin sp. (Pl. XCV, figs. 1-10.)

1851. *Scalpellum tuberculatum* C. R. Darwin, Pal. Soc. Monogr. Foss. Lepadidae, p. 43, pl. i. fig. 10.

1854. *Scalpellum tuberculatum* C. R. Darwin, Ray Soc. Monogr. Sub-class Cirripedia, Balanidae, Synopsis et Index Systematicus, p. 634.

1854. *Scalpellum tuberculatum* C. R. Darwin: J. Morris, Cat. Brit. Foss. 2nd ed. p. 97.

1865. *Scalpellum tuberculatum* C. R. Darwin: J. W. Salter & H. Woodward, Cat. & Chart Foss. Crustacea, p. 27, pl. i. fig. 17.

1877. *Scalpellum tuberculatum* C. R. Darwin: H. Woodward, Brit. Mus. Cat. Brit. Foss. Crustacea, p. 143.

1886. *Scalpellum tuberculatum* C. R. Darwin: J. Kafka, Sitz.-Ber. k. böhm. Gesell. Wiss. Prag (1885), p. 565, pl. i. fig. 7.

1887. *Scalpellum tuberculatum* C. R. Darwin: A. J. Fritsch & J. Kafka, Crust. Böhmischen Kreidef. p. 6, fig. 9.

1888. *Scalpellum tuberculatum* C. R. Darwin: A. Peron, Bull. Soc. Sci. Yonne, vol. xli. (1887) p. 269.

Diagnosis.—Valves with fine ribs radiating from their apices and standing out as blunt spines at each zone of growth. Carina strongly convex transversely, with the parietes narrow and striated. Scutum with the umbo situated about one-third the extent of the valve from the apex, and with two ridges extending from the umbo, one to the basi-lateral angle, and the other to near the rostral angle. Tergum elongately diamond-shape, with a very acute basal angle. Valves of lower whorl with the inner apical half flat and strongly marked with growth-lines.

Remarking on this species, Darwin said (1851, p. 43): "Through the kindness of Mr. Harris, I have examined several valves, which I believe to belong to the same species: the specimens were found in the chalk detritus [of Charing, Kent], and, therefore, may have come from the Upper or Lower Chalk or Chalk-marl; but more probably from the Upper Chalk."

* *titares* = White earth, Chalk.

T. tuberculata has since been recorded by J. Kafka (1886, p. 565) from the Cenomanian of Kamajk, Bohemia, and by A. Peron (1888, p. 269) from the Turonian of Yonne, France. Kafka mentions a single tergum only, and if his figure is accurate, it differs in certain characters from the original tergum from Charing. Peron recorded a small and a very large carina, but gave neither measurements nor figures; he drew attention to the fact that Darwin had supposed the species to come probably from the Upper Chalk, and said that so far as he knew it came from the Turonian.

T. tuberculata occurs fairly commonly in the Cenomanian Chalk Marl near Cambridge, and we have over 150 valves, including 22 valves of the lower whorl. From the Turonian *Terebratulina*-zone at Whyteleafe, Surrey, we have a single scutum, and from the Cenomanian Chalk Marl of Burham, Kent, a single rostrum.

Type.—The collection of the late Mr. Wm. Harris from the Chalk detritus of Charing, Kent, was acquired from his daughter in 1881, by the British Museum (Natural History). Several valves of *T. tuberculata* are represented in the collection, three of which—a carina (I. 14657), scutum (I. 14659), and tergum (I. 14658)—are mounted together on paper, and with them is a label bearing the name "*S. tuberculatum*" in Darwin's handwriting. These are probably the original specimens figured by Darwin, but there is no means of proving this since Darwin gave no measurements of the figured valves of this species. A further label (not in Darwin's handwriting) bearing the words "very valuable" was with the specimens, but whether this was meant to indicate that they are Darwin's original specimens must be left to individual opinion. I consider them to be the types, and since Darwin regarded the carina as the typical valve in *Scalpellum*, that valve is here taken as the holotype.

Measurements.—The valves of this species are exceedingly small, and to judge from these, the largest capitulum could not have measured much more than 5 or 6 mm. in length. Of the upper series of valves the largest examples measure respectively :—

Carina, I. 15850. Length 4.1 mm.; breadth 1.2 mm.

Scutum, I. 15843. Length (from apex to middle of basal margin) 2.5 mm.; breadth 2.6 mm.

Tergum, I. 15851. Length 4.3 mm.; breadth 2.6 mm.

Distribution. [? Cenomanian] Chalk detritus: Charing, Kent; Cenomanian, Chalk Marl: near Cambridge, and Burham, Kent; Cenomanian, Korytzaner Schichten: Kamajk, Bohemia; Turonian, *Terebratulina*-zone: Whyteleafe, Surrey; *Holaster planus*-zone: Armeau and Saint-Julien-du-Sault (Yonne), France.

Description of Valves.—Valves plainly ribbed longitudinally; the ribs are narrow, but become more prominent on the edge of each zone of growth, where the ribs are thicker and usually stand out as short blunt spines.

Carina (Pl. XCV. fig. 1) very narrow, either slightly bowed

inwards, straight, or bowed outwards; tectum strongly convex transversely, not carinate; basal margin almost rounded to bluntly angular; in young specimens, as shown by the periods of growth, the basal margin was almost straight; parietes slightly bent inwards, narrow, much less than half the width of the tectum, and marked with almost parallel growth-lines; inner surface of valve deeply concave for the lower two-thirds, the upper third of the valve being solid and marked with lines of growth, indicating that the valve projected freely to that extent.

Scutum (Pl. XCV. fig. 2) trapezoidal, umbo situated on the ocludent margin about one-third the extent of the valve from the apex; almost flat to strongly convex; four-sided, the lateral or tergal margin slightly longer than the basal margin, with which it makes an angle of about 70° ; the basal margin much longer than the lower part of the ocludent margin, with which it makes almost a right angle, the upper and lower portions of the ocludent margin making an angle of about 135° ; the upper ocludent margin, said Darwin, "homologically corresponds with the tergal margin of the other cretaceous species and with the upper, nearly straight, portion of the ocludent margin in the tertiary *S. magnum* and the recent *S. vulgare*." The edge of the upper ocludent margin is upturned and thickened, forming a prominent ridge, with its apex projecting beyond the lateral margin; a second prominent ridge extends from the umbo to the basi-lateral angle; a third ridge, barely perceptible in some specimens, extends from the umbo to the basal margin, near to the rostral angle. On the inner surface there is a deep hollow for the adductor muscle; along the upper ocludent margin the inner surface is slightly raised, which corresponds to the outer thickened ridge, the space between the two ridges being concave; the inner ridge extends to the umbo, whence it becomes more pronounced and turns inwards, forming a prominent ridge above the hollow for the adductor muscle.

Tergum (Pl. XCV. fig. 3) elongately diamond-shape, slightly angular transversely; the ocludent margin is thickened owing to the presence of a ridge on the outer and inner edge, corresponding with those on the upper ocludent margin of the scutum; close and parallel to the ocludent margin is a ridge which becomes prominent near the scutal margin and extends beyond it; a very prominent straight ridge extends from the apex, and thickens towards the very acute basal angle; scutal and lower carinal margins almost equal in length, and longer than the ocludent and upper carinal margins, which latter are also of almost equal length and together make a right angle.

Valves of the lower whorl (Pl. XCV. figs. 4-8). These are ornamented externally like the scutum, tergum, and carina. The apical half of their inner surface is almost flat and marked with lines of growth, showing that these valves must have projected freely and overlapped the bases of the valves of the upper

whorl; the lower half is considerably concave. Umbo of valves apical. The valves are much less modified than is the case with the valves composing the lower whorl in the more typical forms of *Scalpellum*, and consequently their position in the capitulum is not so readily determinable. Seventeen of the valves are symmetrical, and five asymmetrical. Of the symmetrical valves, nine have an extremely concave basal margin with produced lateral angles (Pl. XCV. fig. 4) and probably represent rostra; five others have a much less concave basal margin (Pl. XCV. fig. 8) and may represent sub-carinæ. The valves just mentioned are thought to be rostra and sub-carinæ, owing to the pronounced concavity of the inner part of the valve near the base. The three remaining symmetrical valves probably represent median lateral valves (Pl. XCV. fig. 6). They differ from the supposed rostra and sub-carinæ in the smaller concavity of the inner basal part of the valve, and in the growth periods being formed of two downward curves which meet on the median line, gradually becoming more obtuse towards the basal margin. Of the asymmetrical valves, two are subtriangular in shape with a recurved acute apex, and probably represent carinal latera (Pl. XCV. fig. 7); the three others, which may be rostral latera (Pl. XCV. fig. 5), are about twice as wide as long, and are divided unequally by a fold extending from the apex to a position on the basal margin about two-thirds the distance from the rostral angle, the basal margin on each side being concave.

Structure and Affinities.—While Darwin had little doubt that the scutum and tergum figured by him belonged to the same species, he did not feel so certain with regard to the carina, and he pointed out that this valve had a close general resemblance to the same valve in *Pollicipes rigidus* J. de C. Sowerby. A specimen of *T. tuberculata* in the British Museum (Natural History), registered I. 14656, formerly in the Harris Collection, affords valuable evidence on this point, for it consists of the carina and the paired terga in position (Pl. XCV. fig. 9), and proves that the carina really does belong to the same species. Darwin stated also that the apex of the carina did not project freely in this species, but an examination of the carinæ from Charing, including the type, and of the numerous carinæ from the Chalk Marl of Cambridge, shows that the upper part of the inside of the valve is much thickened to one-third of its length from the apex (Pl. XCV. fig. 1c), and this portion is marked with growth-lines, showing that it must have projected freely to that extent. Proof of this is afforded by the specimen I. 14656 from Charing (Pl. XCV. fig. 9), in which the carina and terga are in position, for the carina there projects freely.

The carina, scutum, and tergum only of *T. tuberculata* were known to Darwin, but the specimens from Cambridge include several other valves which enable us to add much to our knowledge of the capitulum. The ornamentation of these valves is so characteristic that no doubt can be entertained as to their belonging to this species. Although there are as many as twenty-

two valves*, other than scuta, terga, and carinae, to judge by their structure, none appear to have formed upper latera, or at all events to fit between the scuta and terga, as do the upper latera in most forms of *Scalpellum*. Moreover, the form of the scuta and terga and the structure of their inner surface shows that the tergal margin of the scutum and the scutal margin of the tergum were in close proximity to each other. In this connection Darwin said (1851, p. 44): "I have no doubt that the ridge along the upper occludent margin of the scuta, and that on the occludent margin of the terga, together with their projecting points, are related to each other, owing to the close contact of these valves." It follows, therefore, that if no upper latera were present, the upper whorl of valves in *T. tuberculata* comprised only five valves, namely, a carina, a pair of terga, and a pair of scuta. The valves of the lower whorl, as mentioned in their description, must have overlapped the bases of the valves of the upper whorl, and if we are correct in designating these valves as rostrum, rostral latus, median latus, carinal latus, and sub-carina, the lower whorl would consist of at least eight valves, making thirteen valves for the whole capitulum (see restoration, Pl. XCV. fig. 10).

In the number and arrangement of the valves of the capitulum *Titanolepas tuberculata* approaches the forms of *Scalpellum* grouped by H. A. Pilsbry † under the genus *Calantica* Gray, and comes nearest to those included by him in the section *Scillaelepas* Seguenza, of which the type is *S. carinata* Phillipi sp., from the Pliocene of Messina, Sicily. The capitula of the species grouped under *Calantica* closely resemble that of *Pollicipes*, but differ in that there is only a single basal whorl of valves, comprising three pairs of latera, a rostrum, and a sub-carina. The species included by Pilsbry under the section *Scillaelepas* are chiefly characterized by the absence of an upper lateral plate in the upper whorl, which consequently consists only of five valves, and by the bases of the valves of the upper whorl being overlapped by those of the lower whorl; the umbo in all the valves is apical. While *T. tuberculata* agrees with these species in having five valves only in the upper whorl, and in the valves of the lower whorl overlapping those of the upper whorl, it differs from all the species included under the genus *Calantica* and the section *Scillaelepas* by the umbo of the scutum being in a sub-central position.

We have in *T. tuberculata*, therefore, a species agreeing in all essential characters with the forms of *Calantica* (*Scillaelepas*), except that it has a more specialized form of scutum. The

* Two further valves have since been noticed among the Cirripede material from the Chalk detritus of Charing, Kent, in the British Museum (Natural History). These are identical with the valves from Cambridge, which I consider to be rostral, and are registered I. 14663, I. 14664. A further rostrum has been found in the Chalk Marl of Burham, Kent.

† H. A. Pilsbry, "On the Classification of Scapelliform Barnacles," Proc. Acad. Nat. Sci. Philadelphia, 1908, pp. 106-107; "The Barnacles (Cirripedia) contained in the Collections of the U.S. National Museum," Bull. U.S. Nat. Mus. No. 60, 1907, pp. 8-9.

fossil species that can be definitely referred to *Calantica* (*Scillelepas*) are found in Tertiary rocks, viz. *Scillelepas paronae* from the Miocene of the neighbourhood of Turin, Italy, and *S. carinata* and *S. ornata* from the Pliocene of Messina, Sicily, so that it is an important advance to show that a representative of the genus existed so far back in time as the Cenomanian. It is certainly remarkable to find that *T. tuberculata* had a more highly specialized scutum than the Tertiary and recent species, and to mark this advance in the evolution of the group, I place it in a new sub-genus, *Titanolepas*. This course is the more desirable since *T. tuberculata* may represent a side line of development from the ancestral *Scillelepas* line, which, by the suppression of the lower whorl of valves, and by the umbo of the carina becoming sub-central, may eventually have given rise to the genus *Orymaspis*.

For help in connection with this paper, I wish to express my indebtedness to Dr. F. A. Bather, Dr. W. T. Calman, Mr. C. P. Chatwin, and Dr. H. A. Pilsbry.

EXPLANATION OF THE PLATES.

All the specimens here figured are in the collection of the Geological Department of the British Museum.

PLATE XCIV.

Zeugmatolepas mockleri Withers, gen. et sp. n.

- Fig. 1. Carina. Cenomanian, Chalk Marl: near Cambridge. I. 15820. *a*, outer view; *b*, side view; *c*, inner view.
 2. Carina, I. 15821. *a*, outer view; *b*, side view; *c*, inner view.
 3, 4, 5, 6. Scuta (various forms), I. 15822-I. 15825. } *a*, outer view; *b*, inner view.
 7. Tergum, I. 15826. }
 8. Upper latus, I. 15827.
 9. Rostrum, I. 15828.
 10. Several valves in position, including the carina, I. 15829.
 11. Holotype. Nearly complete capitulum showing the left side, I. 15830.
 12. Several valves in position, I. 15831.
 13. Nearly complete capitulum showing the right side, I. 15832.
 14. Restoration of capitulum based on the above material from the Chalk Marl of Cambridge. *c.*, carina; *s.*, scutum; *t.*, tergum; *u.l.*, upper latus; *r.*, rostrum; *l.l.*, lower latera; *s.c.*, sub-carina.

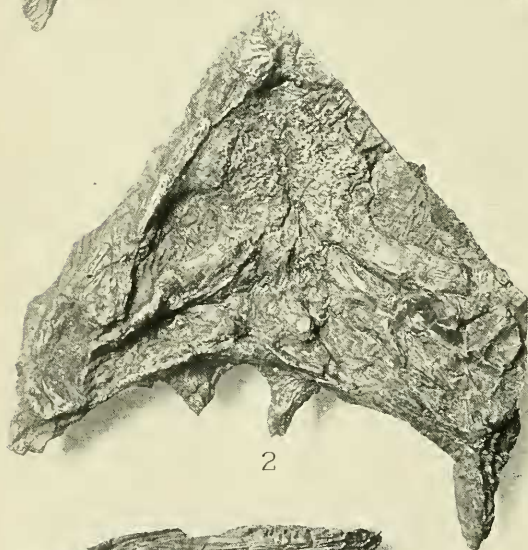
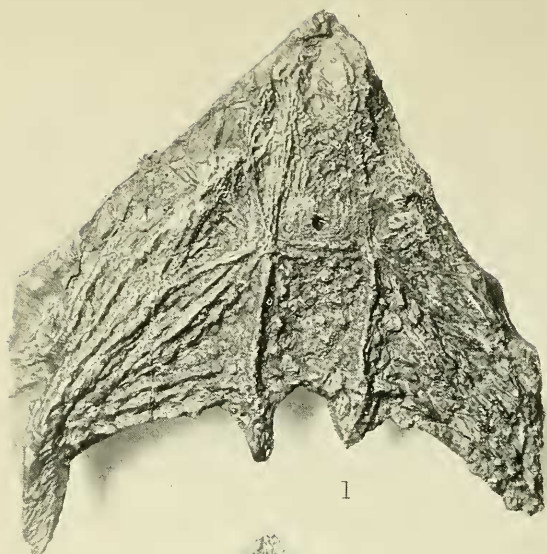
Figs. 1, 2, 4, 9-13, $\times 10$ diameters; figs. 3, 5-8, 14, $\times 5$ diameters.

PLATE XCV.

Calantica (*Titanolepas*) *tuberculata* Darwin sp.

- Fig. 1. Carina. Cenomanian, Chalk Marl: near Cambridge. I. 15842. *a*, outer view; *b*, side view; *c*, inner view; *d*, transverse section near apex.
 2. Scutum, I. 15843 (figure reversed).
 3. Tergum, I. 15844. } *a*, outer view; *b*, inner view.
 4. Rostrum, I. 15845.
 5. Rostral latus, I. 15846.
 6. Median latus, I. 15847.
 7. Carinal latus, I. 15848 (figure reversed). }
 8. Sub-carina, I. 15849.
 9. Carina and pair of terga in position. [? Cenomanian] Chalk detritus; Charing, Kent. I. 14656.
 10. Restoration of capitulum, based on disconnected valves from the Chalk Marl of Cambridge. *c.*, carina; *s.*, scutum; *t.*, tergum; *r.*, rostrum; *r.l.*, rostral latus; *m.l.*, median latus; *c.l.*, carinal latus; *s.c.*, sub-carina.

Figures 1-10 $\times 10$ diameters.



3

BATRACHIDERPETON LINEATUM.



4



5

BATRACHIDERPETON LINEATUM.